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13. ABSTRACT (Maximum 200 words)  The 1993 Physical Metallurgy Gordon Research Conference on "Materials by Design" was held from 2 to 6 August, 1993 at Plymouth State College South, Plymouth NH, with J.B. Cohen and G.B. Olson of Northwestern University as chairmen. Eleven of the twenty-six speakers were from foreign countries, and the nearly 100 total participants showed a similar distribution. Overall, there was a healthy mixture of scientists and engineers from universities, national laboratories, and private industry, including young researchers and graduate students as well as established scientists. The program explored a new relationship between science and engineering tuned to the new responsibilities of the science enterprise in the post-Cold War era.		
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1993 GORDON RESEARCH CONFERENCE  
ON PHYSICAL METALLURGY:  
"MATERIALS BY DESIGN"

The 1993 Physical Metallurgy Gordon Research Conference on "Materials by Design" was held from 2 to 6 August, 1993 at Plymouth State College South, Plymouth NH, with J. B. Cohen and G. B. Olson of Northwestern University as chairmen. Eleven of the twenty-six speakers were from foreign countries, and the nearly 100 total participants showed a similar distribution. Overall, there was a healthy mixture of scientists and engineers from universities, national laboratories, and private industry, including young researchers and graduate students as well as established scientists.

The innovative program explored a new relationship between science and engineering tuned to the new responsibilities of the science enterprise in the post-Cold War era. The first session examined methodology for generating and integrating scientific knowledge within a systems engineering framework for the quantitative conceptual design of new materials to meet performance needs. This included application of property/performance relations in specifying complete sets of property objectives, as well as synthesis of process/structure/property relations in design of complex materials with dynamic multilevel structures. The first evening session included educational issues in effective bridging of science and engineering, and the fostering of design creativity.

Subsequent sessions explored a broad range of new design modeling tools made possible by ongoing developments in basic materials science and related fields. Tools for thermodynamics and phase stability included new software and international database systems for multicomponent solution thermodynamics, as well as quantum-mechanical total-energy calculations for both thermochemical and physical property data. Dynamic tools for simulation of microstructural evolution in processing and service included a new diffusion code employing a multicomponent mobility database, numerical simulations of precipitation and coarsening in coherent systems and alloy solidification, atomistic modeling of solution hardening, and continuum modeling of transformation toughening with kinetics-based constitutive laws. An Interface Design session explored the mechanics, nanochemistry and adhesion physiochemistry for control of interfacial phenomena pervasive throughout materials technology.

A final session examined concrete examples of the quantitative application of thermodynamic and kinetic models in the actual design of materials for a range of applications, including cases as complex as materials for multipass welding.

Discussions at the conference were stimulating, despite a somewhat densely packed program. Complaints from some scientists concerning the degree of engineering and commercial content were not unexpected, reflecting an uneasiness with the inevitable changes in the structure of American science that this conference boldly explored. Conference interactions have since led to interdisciplinary group research proposals, and new concepts unveiled at the conference such as biomimetic self-healing intermetallic composites and the materials science of ice cream have received world attention. The experiment was a success.

# 1993 Gordon Research Conference on Physical Metallurgy

## "Materials by Design"

August 2-6, 1993  
Plymouth State College South  
Plymouth, New Hampshire  
J. B. Cohen and G. B. Olson, Chairmen  
R. P. Gangloff and C. L. Briant, Vice-Chairmen

### Program

Monday  
August 2, 1993

Morning 9:00 am - 12:15 pm  
**Design Principles**  
**Chairman: W. Simmons, Army Research Office**

G. B. Olson, Northwestern University  
*Systems Design of Materials: Applications to Steel*

J. D. Embury, McMaster University  
*Design of Multifunctional Materials: High Strength/High Conductivity*

A. S. Argon, MIT  
*Structural Objectives in Design of Materials*

Evening 7:30 pm - 10:00 pm  
**Property/Performance Relations and System Design**  
**Chairman: A. Rosenstein, Bolling Air Force Base, AFOSR**

H. Shercliffe, Cambridge University  
*Property Objectives and Modeling for Design*

W. Flowers, MIT  
*Creative Design and Education*

Tuesday  
August 3, 1993

Morning 9:00 am - 12:15 pm  
**Modeling Tools**  
**Chairman: L. Kaufman, Manlabs, Inc.**

**A) Thermodynamics and Phase Stability**

B. Sundman, Royal Institute of Technology, Stockholm  
*Modeling for a General Thermodynamic Database*

J. Sanchez, University of Texas, Austin  
*Statistical Thermodynamics of Alloys: From Enlightened Phenomenology to First Principles*

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Thursday  
August 5, 1993

Morning 9:00 am - 12:15 pm

**Interface Design**

**Chairman: C. J. McMahon, Jr., University of Pennsylvania**

V. Tvergaard, Technical University of Denmark  
*Interface Mechanics and Materials Design*

R. Carpenter, Arizona State University  
*Nanochemistry and Structure of Interfaces*

N. Eustathopoulos, Institut National Polytechnique de Grenoble  
*Physiochemistry of Interfaces in Materials Design*

Evening 7:30 pm - 10:00 pm

**Dinner Speaker: P. Keeney, Penn State**

*Structure/Property Relations and Design of Ice Cream*

Conference Planning Session

Friday  
August 6, 1993

Morning 9:00 am - 12:15 pm

**Actual Design Examples**

**Chairman: R. Doherty, Drexel University**

A. P. Miodownik, University of Surrey  
*The Role of Thermodynamics in Alloy Design*

J. S. Kirkaldy, McMaster University  
*Thermodynamic and Kinetic Models for Microstructure and Mechanical Property Prediction for Steel*

N. Saunders, ThermoTech, Ltd.  
*Thermodynamic Designs of Alloys*

H. K. D. H. Bhadeshia, University of Cambridge  
*Materials Design for Weldability*